Ind. Jn. of Agri. Econ.
Vol.67, No.4, Oct.-Dec. 2012

ARTICLES

Determinants and Implications of Smallholder Participation in Dairy Co-operatives: Evidence from Uttarakhand State of India

D. Bardhan and M.L. Sharma*

I

INTRODUCTION

Dairy co-operatives have played a key role in India in providing small producer households a remunerative and sustainable access to markets. The network of dairy co-operatives has expanded considerably since the launch of Operation Flood Programme in 1970. There has been an eight-fold increase in their number and a seven-fold increase in their membership since 1980-81. During 1980-81 to 2004-05, milk procured by co-operatives increased from 935 thousand tonnes to 6.381 million tonnes. In spite of the potential inherent in dairy co-operatives to bring smallholder producers within the organised fold and effectively link them to markets, the performance and impact of co-operatives have not been uniform across all the regions of the country. Milk procurement through co-operatives still remains low. As in 2004-05, dairy-co-operatives accounted for only about 7.9 per cent of the total milk procurement at the national level. Further, the distribution of dairy co-operatives in terms of volumes of milk handled, installed processing facilities and marketing infrastructure is highly skewed in favour of a few states. Only four states, viz., Gujarat, Maharashtra, Karnataka and Tamil Nadu contribute over two-thirds of milk procurement by co-operatives, while their share in total milk production is 24 per cent (Birthal and Taneja, 2006). Several earlier studies have also highlighted the intrinsic constraints that limit dairy co-operatives’ growth potential in developing countries (Deininger, 1993 and Francesconi and Ruben, 2007).

In order to enhance the smallholder participation in co-operatives and set opportunities for income generation and sustainable livelihoods, improvements in smallholder commercialisation and technical efficiency in production are necessary. It is increasingly being recognised that commercialisation of surplus output from small scale farming is closely linked to higher productivity, greater specialisation and higher income. The other critical issue involved is that how well milk producers can

*Assistant Professor (Veterinary Economics), Department of Veterinary and Animal Husbandry Extension, College of Veterinary and Animal Sciences and Professor, College of Agribusiness Management, respectively, G.B. Pant University of Agriculture and Technology, Pantnagar – 263 145 (Uttarakhand).

compete in the market. In the long run, relatively efficient farms survive (Costales *et al.,* 2007). If, on an average, a farm is more technically efficient than another, then it is fair to say that the former category is more favourably placed to compete in the market than the latter. Efficiency analysis also provides opportunities to identify the sources of differences in relative performance. This information can be used to see whether the problem of lower profit is due to inefficiency of the farm or due to lack of technology or input use. Research on the role of dairy co-operative societies (DCS) in the above aspects is scarce. In this context, it becomes pertinent to examine empirically the role of dairy co-operatives in enhancing the milk producer households' level of commercialisation and efficiency in production. Another objective involves understanding the factors which influence dairy farmers' decision to participate in dairy co-operatives.

II

METHODOLOGY

The study was carried out in Uttarakhand state of India. The farmers in the state – owing to small land holdings – are severely constrained by insufficient income generation through crop husbandry alone. Due to limited scope of other livelihoods, livestock activity forms an important source of livelihood for almost all the households in the state. Milk constitutes the major livestock product and accounts for 77 per cent of the total output from the livestock sector. The state has two divisions, viz., Kumaon and Garhwal. The study was confined to Kumaon division on account of greater livestock density and better coverage of dairy co-operative network in this division. Livestock density in this division is 114 per sq. km geographic area and 840 per 1000 rural population as compared to the corresponding figures of 78 per sq. km geographic area and 795 per 1000 rural population in Garhwal (Bardhan *et al.,* 2010). This implies that the economic dependence on livestock in this division is more. The average annual milk procurement by dairy co-operatives in Kumaon region is 95,387 kg as compared to 17,581 kg in Garhwal region. The number of functioning DCS in Kumaon region (1,493) is almost twice than that of Garhwal region (795). The average milk procurement per DCS and per DCS member is also substantially higher in Kumaon region (63.89 kg/DCS and 1.20 kg/member, respectively) than Garhwal region (22.11 kg/DCS and 0.34 kg/member, respectively).

Two districts, viz., U.S. Nagar (located in the plains) and Almora (located in hills) from Kumaon region were chosen for the study so as to have a comparative picture of milk production scenario in the plains and hills. Both the districts are rich in livestock resources and also have greater network coverage of the state milk marketing federation. An exhaustive list of all Milk Producers' Co-operative Societies in the two districts was prepared. Based upon cumulative square root of the frequency method, all the societies were stratified into three strata, viz., low, medium and high procurement societies on the basis of milk procurement per day. Among these societies, six milk procurement societies were randomly selected from each of the two districts based upon probability proportion to number of societies in each stratum. Thus a total of twelve milk producers' co-operative societies were selected for the study from the two districts. Table 1 elicits the milk producers' societies selected for the study. A complete enumeration of all milk selling

TABLE 1. DAIRY CO-OPERATIVE SOCIETIES SELECTED FOR THE STUDY

(1)	U.S. Nagar (Plains) (2)	Almora (Hills) (3)
Low procurement societies	Anandpur	Mujholi
	Khurpiya	Gewapani
	Aryanagar	Hawalbagh
Medium procurement societies	Madnapuri	Majhkhali
	Rajpura 2	Patharkot
High procurement societies	Raghownagar	Daulaghat

households of selected societies was then conducted for the purpose of developing a sampling frame. Standard Animal Unit (SAU) was derived to standardise output of different farms with different species of animals (Kumbhare *et al.,* 1983). All the milk selling households were classified on the basis of number of SAUs into three categories, viz., small, medium and large herd size through cumulative square root frequency technique. From the six selected societies in each district, 75 households were randomly selected having representation from member and non-member categories on proportionate basis. Both the sets of samples of selected households from the member and non-member groups had representation from different herd size categories of dairy farms on proportionate basis. Thus, a total of 150 milk selling households from villages having dairy co-operative societies were selected from the two districts. Table 2 presents the herd-size category wise distribution of households selected across member and non-member groups in the plains and the hills.

TABLE 2. DISTRIBUTION OF DIFFERENT HERD SIZE CATEGORY SAMPLE HOUSEHOLDS ACROSS GROUPS

Plains		Hills	
Herd size category (1)	No. of households (2)	Herd size category (3)	No. of households (4)
Members		Members	
Small	24	Small	31
Medium	20	Medium	15
Large	10	Large	9
Overall	54	Overall	55
Non-members		Non-members	
Small	11	Small	16
Medium	4	Medium	4
Large	6	Large	0
Overall	21	Overall	20
Total	75		75

Data for the present study were collected through personal interview method with the help of a well-structured, comprehensive and pretested interview schedule. Data were collected in regard to demographic particulars of milk producing households, resource ownership, technical characteristics of dairy enterprise, consumption and disposal patterns of milk, component wise cost of milk production, and information in institutional support system. The data collected during the period of investigation were scrutinised, tabulated and compiled systematically and analysed thereafter using descriptive analysis, functional analysis, and stochastic frontier production analysis commensurate with the objectives of the study.

Estimation of Technical Efficiency in Milk Production

The objective of the present investigation was to compare the level of commercialisation and efficiencies of the farm households – who are members and non-members of dairy co-operatives – in milk production. Therefore, it was very important to consider the effect of various species/breed of milch animals kept by the farm households. For this purpose, Standard Animal Units (SAU) of the bovine stock was derived for each farm household as per specification given by Kumbhare *et al.* (1983).[1] The standard animal unit was derived to standardise output of different farms with different species of dairy animals. The output variable was taken as fat corrected milk (FCM) production per standard animal unit per day in litres based on the following formula as prescribed by Hemme (2000):

FCM milk = (milk production x fat in % x 0.15) + (milk production x 0.4)

The two most popular approaches to estimation of technical efficiency are the parametric stochastic frontier analysis (SFA) and non-parametric Data Envelopment Analysis (DEA). Each of the two approaches has its own strengths and weaknesses. While the advantage with DEA lies in its general non-parametric frontier, its limitations are related to the fact that it attributes all deviations from the frontier to inefficiency ignoring stochastic noises in the data. On the other hand, the strength of SFA lies in its ability to segregate the error term into two components, viz., inefficiency and statistical noise, but it can be implemented only by imposing a specific functional form and hence the efficiency indicators obtained can be sensitive to chosen function form (Gelan and Muriithi, 2010). It has been suggested in earlier works that SFA with a composed error term is more appropriate to estimate technical efficiency in agriculture, particularly in the developing countries, where the probability of the data being influenced by measurement errors and the effects of weather conditions, disease, etc., are high (Kumar *et al.*, 2004). The present study used the stochastic frontier production function to estimate the technical efficiency in milk production in the study area. The stochastic frontier production function can be written in the general form following (Aigner *et al.*, 1977), as:

$$Y_k = f(X_{ik}) \exp(v_k + u_k)$$

Where Y_k is the output of the k-th farm, X_i 's are the inputs to the production process, v_k is a random variable representing statistical noise and other stochastic shocks entering into the definition of the frontier. It is almost universal to specify this random term as independent normally distributed with zero mean and constant unknown variance σ_v^2, and independent of X_i, i.e., $v_k \sim N(0, \sigma_v^2)$.

u_k is a non-negative random variable representing technical inefficiency and is assumed to be distributed independently of v_k and X_i. It can be measured by the difference between maximum output Y* (estimated through the stochastic frontier production function) and observed output, Y_i. Thus, farm-specific inefficiency is the distance below the frontier (Y_i – Y*). The above stochastic frontier production function can be estimated by maximum likelihood once a density function for u_k is specified.

Milk production is a complex biological process influenced by several genetic, non-genetic and environmental factors. Though it is not possible either to identify all the factors affecting milk production or to take into account all of them in a single production function framework (Dixit, 1999). The input-output relationship in this study has been explored at the household level and not for individual species of animals. For this reason, some of the important variables such as order of lactation of milch animals and stage of lactation of milch animals have been purposively eliminated due to difficulty in incorporating these information at an aggregated milk production function. Hence, it was assumed that the eliminated variables were not significantly varying between farm households in the study area (Saha and Jain, 2004).

The technical efficiency was determined by considering the stochastic frontier Cobb Douglas production function approach, wherein:

Y_k = fat corrected milk yield (litre) per standard animal unit per day,
X_{1k} = depreciation on fixed assets (Rs.) per annum per SAU for k-th farm,
X_{2k} = veterinary expenses (Rs.) incurred per annum per SAU by k-th farm,
X_{3k} = miscellaneous expenses (Rs.) incurred per annum per SAU by k-th farm,
X_{4k} = index for green fodder used per annum per SAU in k-th farm,
X_{5k} = index for dry fodder used per annum per SAU in k-th farm,
X_{6k} = index for concentrate used per annum per SAU in k-th farm and
X_{7k} = unpaid family labour expenditures (Rs.) incurred per annum per SAU in k-th farm.

To take care of variations in the type of fodder fed at different times and the mixture of fodder fed; the feed inputs were standardised to nutrition units in terms of a feed index developed from Digestible Crude Protein (DCP) and Total Digestible Nutrients (TDN) content in the feed and fodder. The quantity of feed and fodder fed were converted to DCP and TDN equivalents using the standardised conversion units of different types of Indian feed and fodder. The estimates of feed index were worked out for the feeds and fodder for individual farms using the formulae DCP + (TDN/7.5) given by Kumar and Singh (1980).

Depreciation on cattleshed and dairy equipments was worked out using straight line method taking into account the useful life of the asset concerned. Based on the assumption of 10 years of productive life of dairy animals, the depreciation rate was worked out as 10 per cent per annum. Similarly, the depreciation rate for other fixed assets were taken as 5 per cent for pucca buildings and 10 per cent for chaff cutter based appropriate assumptions regarding their productive lives (20 years for pucca buildings and 10 years for chaff cutter).

The value of family labour was imputed upon the prevailing wage rate in the study area after necessary conversion of the labour units into standard unit irrespective of age and sex. For this, man equivalent days were computed – as per the specifications of Rao and Rao (1991) – as one man-day is equal to 8 hours of work done by an adult male worker; one female day is equal to 2/3 man-day and one child labour day is equal to ½ man-day.

The above estimates of output (milk produced per annum per SAU) and various inputs to the production process were derived on the basis of data collected for three seasons (winter, summer and rainy) for each of the species of dairy animal per day multiplied by the number of days per season (winter: 120 days; summer: 125 days and rainy; 120 days) (Saha and Jain, 2004).

Explaining Dairy Co-operative Membership

A Logit model was formulated in an attempt to explain the factors that are associated with dairy co-operative membership. The dependent variable is a dummy variable, dichotomous in nature (dependent variable assumes a value of 1 in case a producer sells to DCS and 0 otherwise). The Logit model is of the form:

$$\text{Ln}\ (Pi/1\text{-}Pi) = \alpha + \Sigma\beta_i X_{ik} + \Sigma\beta_i D_{ik} + e_i$$

Where, X is the vector of independent variables, D is vector of dummy independent variables and β_i's are the coefficients to be estimated.

The following are the detailed specifications of explanatory variables included in the model:

X_{1k} = Herd size of k-th household (measured as standard animal unit)
X_{2k} = Distance to market (kms) from k-th household
X_{3k} = Age of head of k-th household (years)

X_{4k} = Education level of k-th household head (0-illiterate, 1-read and write, 2-Primary, 3-Middle, 4-High school, 5-Intermediate, 6-Graduation and above)

X_{5k} = Size of landholding (acres) of k-th household

D_{1k} =Dummy variable for access to information (whether k-th household has easy access to information: Yes=1; No=0)

D_{2k} =Dummy for non-farm income (whether k-th household has a non-farm income source: Yes=1; No=0).

Alternative specifications of the above model, including household education index, road condition, farm experience and extension contact, also were estimated. However, the parameter estimates associated with these variables were not statistically significant at accepted levels. Hence, these were dropped from the model. The final estimated Logit model, thus, included the above-specified variables only. The estimated coefficients represent the change in the log of odds of selling to DCS. A positive estimated coefficient implies an increase in the likelihood that a respondent will sell to DCS with a unit increase in the concerned explanatory variable.

Impact of Participation in DCS

The objective here is to see whether participation in co-operatives affects farmers' level of commercialisation (denoted as the proportion of output sold) and technical efficiency in milk production. In an attempt to ascertain whether participation in DCS significantly influenced dairy farmers' level of commercialisation, a multivariate linear regression equation was fitted wherein the proportion of fresh milk output sold by households was taken as the dependent variable. In addition to a set of explanatory variables representing farm and farmer characteristics and transaction cost variables, a dummy variable representing co-operative membership was included as an exogenous variable in the model. Two regression equations were fitted – one each for the plains and hills – pooled over different categories of households. To control the effect of herd size in the pooled equations, herd size was included as an additional independent variable in the final model. Multicollinearity among independent variables was tested by preparing a zero-order correlation matrix, for both the data sets, i.e., for plains and hills, separately.

For the second objective, an attempt was made to identify different factors so as to assess their impact on technical efficiency of the farm households. Functional analysis was undertaken to accomplish the above taking technical efficiency index as regressand while the determinants as regressors. Two regression equations were fitted – one each for the plains and hills – and a dummy variable representing co-operative membership was included as one of the independent variables. To control for the effect of herd size in the pooled equations, herd size was included as an additional independent variable.

Thus, following two sets of multivariate regression equations were applied:

$$PROP.SOLD_1 = \alpha + \beta_i X_i + \beta_i\, COOP.MEMB + \mu_i$$
$$TE_i = \alpha + \beta_i X_i + \beta_i\, COOP.MEMB + \mu_i$$

Where, PROP.SOLD and TE represent percentage of milk output sold and technical efficiency index; X_i's are the set of explanatory variables and COOP.MEMB is a dummy variable representing co-operative membership status (COOP.MEMB = 1 if the farmer is a member of DCS and COOP.MEMB=0 if he is not a member). The specific variables used in this study as regressors in the two sets of regression equations are described in Table 3.

TABLE 3. VARIABLES CONSIDERED IN THE STUDY

Variables (1)	Description (2)	Measurement (3)
Price received	Weighted average price received for each litre of milk normally sold	Rupees (In several instances, milk of different species and breeds like crossbred cow, indigenous cow and buffalo was sold by individual producer. Thus, the weighted average price of milk, taking quantity of each type of milk as weights, was considered in the study).
Herd size	Number of milch animals owned by household	Measured as standard milch animal units (1 indigenous cow = 1.3 buffalo = 1.4 crossbred cow)
Family size	Number of members of household	Number measured as adult equivalents (2 adult male=3 adult females=4 children
Edication-HH head	Education level of household	0-Illiterate, 1 Read and write, 2-Primary, 3-Middle, 4-High School, 5-Intermediate, 6-Graduation and above
Age-HH head	Age of household head	Number of years
Non-farm income	Whether a household member has non-farm income source	1 = Yes 0 = No
Landholding	Size of landholding of household	Hectares (ha)
Milk production	Quantity of milk produced per day per SAU	Litres (Fat corrected milk)
Access to information	Whether has easy access to information	1 = Yes 0 = No
Prop. of output sold	Percentage of milk produced sold	Per cent
Cooperative membership status	Whether the farmer is a member of Dairy Cooperative of not	Member = 1, Non-member=0

III

RESULTS AND DISCUSSION

Frontier Functional Analysis for Milk Production

The level of technical efficiency of a particular farm is characterised by the relationship between observed production and some ideal or potential production. The measurement of farm-specific technical efficiency is based upon deviation of observed output from the best production or efficient production frontier. If a farm's actual production point lies on the frontier, it is perfectly efficient. If it lies below the frontier, then it is technically inefficient, with the ratio of the actual to potential production defining the level of efficiency of the individual farm. Stochastic estimations incorporate a measure of random error. This involves the estimation of a stochastic production frontier, when the output of a farm is a function of a set of inputs, inefficiency and random error. Maximum likelihood estimation (MLE) technique was employed to estimate the parameters of the Cobb-Douglas production function using Frontier 4.1 version software package.

The results for the same for member and non-member households are presented in Table 4. In the case of the plains, the generalized likelihood ratio (LR) statistic for testing the null hypothesis for the absence of inefficiency effects in the Cobb-Douglas stochastic frontier production were 5.096 and 9.214, respectively for member and non-member households. The calculated LR statistics were statistically significant in both the cases, implying that the null hypothesis that there were no technical inefficiency effects in the Cobb-Douglas stochastic production function was rejected. The estimates of the gamma values of 0.926 and 0.989, respectively for member and non-member households, were all statistically significant. Saha and Jain (2004) had reported a relatively lower gamma value (0.723) from their study on milk production efficiency in Haryana. The high levels of gamma values in this study indicate that inefficiencies in individual farms explained very high proportion of variations in milk yield. The statistical significance of the gamma values also indicates that the frontier models were significantly different from the OLS models or the deterministic frontier, in which there were no random errors in the production function. Concentrate was found to be a significant factor positively influencing milk production in MLE models for both the data sets. Green fodder was significant only in case of non-member households and the effect was found to be negative, indicating excessive use of this resource. Veterinary expenditures exerted significant influence only in case of member households and the effect was negative, indicating that there is need to curtail excessive expenditures on veterinary care. Depreciation had significant and positive effect in the case of member households, while its effect on non-member group was non-significant. The positive effect of depreciation for member households indicated that equipments on these farms were well maintained and depreciated less. Dry fodder, miscellaneous expenditures and family labour did not have significant influence on milk production in the case of both member and non-member groups.

TABLE 4. MAXIMUM LIKELIHOOD ESTIMATES OF STOCHASTIC COBB-DOUGLAS FRONTIER MILK PRODUCTION FUNCTIONS OF STANDARD ANIMAL UNITS OF HOUSEHOLDS

	Plains		Hills	
	Member	Non-member	Member	Non-member
Variables	MLE estimates	MLE estimates	MLE estimates	MLE estimates
(1)	(2)	(3)	(4)	(4)
Constant	0.782	1.161	0.112	0.226
	(0.197)	(0.436)	(0.262)	(0.536)
Depreciation	0.295*	0.353	0.220***	0.714***
	(0.161)	(0.506)	(0.034)	(0.097)
Veterinary expenditure	-0.121**	0.179	-0.007	-0.044*
	(0.054)	(0.146)	(0.024)	(0.020)
Miscellaneous expenditures	0.039	-0.117	-0.087	0.369**
	(0.079)	(0.172)	(0.075)	(0.081)
Green fodder index	0.033	-0.844**	0.008	0.030*
	(0.132)	(0.380)	(0.013)	(0.014)
Dry fodder index	0.068	-0.069	1.039*	0.766***
	(0.041)	(0.051)	(0.397)	(0.149)
Concentrate index	0.214**	0.327***	0.212***	0.023*
	(0.102)	(0.080)	(0.049)	(0.012)
Family labour	0.027	0.012	0.414**	-0.239
	(0.032)	(0.131)	(0.196)	(0.170)
$\gamma = s^2u/s^2s$	0.926***	0.989***	0.969***	0.001
	(0.067)	(0.109E-03)	(0.867)	(0.003)
LR test of the one-sided error	5.096*	9.214***	16.21***	0.007
Log-likelihood function	36.62	21.89	33.41	0.293E-05

In the case of the hills, the generalized LR statistic for testing the null hypothesis for the absence of inefficiency effects in the Cobb-Douglas stochastic frontier production was 16.21 in case of member households. This ratio statistic was significant, implying that the null hypothesis that there were no technical inefficiency effects was rejected. The estimate of gamma value of 0.969 for the same group was significant, indicating that the frontier model was significantly different from the OLS model. The high gamma value implies that inefficiency effects in individual farms explain a very high proportion of variations in milk yield in case of this group of households. The elasticity for milk production for depreciation was highly significant for member group. The effect of depreciation was positive suggesting appropriate maintenance of equipments in these farms. Dry fodder and concentrates were significant for member households and the effect of these variables were positive. Veterinary expenditures, miscellaneous expenditures and green fodder had no significant effect in case of member group suggesting that these variables did not have significant impact on frontier levels of milk production. Family labour was a significant variable in case of member households and the effect was positive, implying that there is scope of profitably increasing labour hours devoted to taking care of animals. In contrast to what was observed in case of member households, the estimated LR test statistic (0.293E-05) was highly non-significant in case of non-member households, implying that the null hypothesis for the absence of inefficiency effects was accepted. The estimated gamma value was also very low (0.007), indicating that inefficiency effects explained negligible proportion of variations in milk yield. This implies that the frontier model was not significantly different from the OLS model. The variables which were significant in case of non-member households were veterinary expenditures, depreciation, miscellaneous expenditures, green fodder dry fodder and concentrate. The effect of the first variable was negative, while all the remaining significant variables had positive effect.

Estimation of Technical Efficiency

To determine the technical efficiency of the different herd-size categories of households across groups, the mean technical efficiency indices of milk production for different sample farms were obtained. The indices of mean technical efficiency of farm households are presented in Table 5. In the plains for overall category, the mean efficiency of non-member households (90.14) was better than that of member households (86.48). For each herd-size categories, also, the technical efficiency was higher for non-member group as compared to member group. Based on the technical efficiency of the most efficient farm in each herd-size category over groups, the average potential to increase milk production was determined. The potential for technical efficiency improvement of milk production in terms of reducing milk production costs was higher for member households (11.67 per cent) than that of non-member households (9.85 per cent). Among different herd-size categories, the potential for improvement in technical efficiency was higher for medium and large categories of member group than medium and large categories of non-member group. However, for small farmers, the potential for improving technical efficiency was higher in case of non-member group than member group. The mean potential to

TABLE 5. MEAN TECHNICAL EFFICIENCY ESTIMATED AND INCREASING EFFICIENCY POTENTIAL OF DIFFERENT HERD-SIZE CATEGORY HOUSEHOLDS OVER GROUPS

	Plains		Hills	
Herd-size categories (1)	Mean technical efficiency (2)	Mean potential to increase efficiency (3)	Mean technical efficiency (4)	Mean potential to increase efficiency (5)
Member				
Small	85.93	10.69	85.97	14.01
Medium	88.29	9.83	85.70	14.22
Large	84.49	10.31	80.78	16.98
Overall	86.48	11.67	85.03	14.89
Non-member				
Small	88.41	11.58	99.76	0.01
Medium	92.14	6.89	99.74	0.02
Large	92.35	5.19	-	-
Overall	90.14	9.85	99.75	0.01

increase efficiency also point towards the extent of reduction in milk production costs, if the average farmer was to achieve the efficiency level of its most efficient counterpart. Thus, for member group, if the average farm in the sample was to achieve efficiency level of its most efficient counterpart, then the average farmer would realise a cost saving of 11.67 per cent. A similar calculation for non-member group revealed a cost savings of 9.85 per cent.

A perusal of Table 5 shows that in the hills, the mean technical efficiency was very high for non-member households (99.75 per cent). This is consistent with the earlier finding of MLE model, where the LR statistic was found to be highly non-significant. This implies lack of inefficiencies across households in the group. The mean technical efficiency of overall category of member households was 85.03 per cent. Mean potential to increase efficiency for overall category for member group was 14.89 per cent. This implies that if the average farm in the member group was to achieve the technical efficiency level of the most efficient farm, then the average farm would realise a cost saving of 14.89 per cent. The mean potential to increase efficiency for non-member group was negligible implying that farms in this group were more or less operating on the frontier.

Milk Marketing Patterns

Table 6 presents the milk marketing patterns of different herd size category dairy farmers in the plains. As is obvious, milk production per household increased with increase in herd size across both member and non-member groups. There were, however, no statistically significant differences in milk production per household and milk yield (milk production per SAU) across the two groups. Marketable surplus – considering the minimum per capita milk requirement as prescribed by ICMR – increased with herd size. In absolute terms, marketed surplus also increased with herd size across all groups. Marketed surplus was lesser than marketable surplus for all categories of dairy farmers, implying that surplus milk was retained by milk producing households, which are most probably converted into milk producers for internal consumption. Arora *et al.* (1998) had also reported, in a study in North-West Uttar Pradesh, that households' consumption of milk exceeded their nutritional milk requirement. For overall category, marketed surplus per household of member group (11.44 litres/household/day) did not differ significantly from that of non-member group (10.70 litres/household/day). When compared across herd-size categories, only in case of small category, the marketed surplus per household for member group was significantly higher than that of non-member group. When expressed as percentage of production, marketed surplus for member group was higher for small (71 per cent) and large (75 per cent) category farmers as compared to medium (59 per cent) category farmers. For non-member households, percentage marketed surplus increased with herd size (56 per cent, 72 per cent and 77 per cent, respectively for small, medium and large category farmers). Price received per litre of milk was significantly higher for non-member households (Rs.18.11/litre) than that of member households (Rs.16.27/litre) for overall category. When analysed across herd size categories, small, medium and large dairy farmers in non-member group received significantly higher prices (Rs.17.74, Rs.19.23 and Rs.18.03 per litre of milk, respectively) as compared to the same herd-size categories of member group (Rs.15.79, Rs.16.60 and Rs.16.73 for small, medium and large farmers, respectively).

TABLE 6. MILK MARKETING PATTERNS IN PLAINS

(*per household per day*)

(1)	Milk production (2)	Milk yield (3)	Milk retained (4)	Milk requirement* (5)	Marketable surplus (6)	Marketed surplus (7)	Marketed surplus (per cent) (8)	Price received (Rs./lit.) (9)
Members								
Small	8.75	6.31	2.56[c]	1.21	7.54	6.19[c]	70.74	15.79[a]
Medium	19.76	7.36	8.05	1.26	18.50	11.71	59.26	16.60[a]
Large	30.77	6.14	7.75	1.26	29.51	23.02	74.81	16.73[a]
Overall	17.01	6.66	5.56	1.25	15.77	11.44	67.25	16.27[a]
Non-members								
Small	8.56	6.39	3.75[o]	1.15	7.41	4.81[c]	56.19	17.74[a]
Medium	17.96	7.35	5.02	1.48	16.48	12.94	72.05	19.23[a]
Large	28.47	4.29	6.61	1.33	27.14	21.86	76.78	18.03[a]
Overall	15.42	5.93	4.72	1.26	14.66	10.70	69.39	18.11[a]

*Milk requirement per households calculated as per ICMR recommendations (300 ml per capita per day).

Differences between figures – pertaining to a particular parameter – having same superscripts across herd-size categories over groups are significant.

Table 7 presents the milk marketing patterns of different herd size category farmers in the hills. As observed in the plains, total milk production per household increased with herd size across different groups of dairy farmers. There were no significant differences in milk production per household across different herd-size category households over groups. Milk yield (milk production/SAU), however, was significantly higher for small and overall category farmers of non-member group than their counterparts in member group. Marketed surplus - in absolute terms – increased with increase in herd size across all groups. There was no significant difference between the marketed surplus for member group (6.89 litres/household/day) and non-member group (6.33 litres/household/day). Herd size category wise analysis, also, revealed no significant differences in marketed surplus across different herd sizes over groups. As observed in the plains, in percentage terms, marketed surplus was higher for small (60 per cent) and large (83 per cent) farmers than that of medium farmers (56 per cent) for member group. Percentage marketed surplus was also higher for small farmers (71 per cent) as compared to medium farmers (67 per cent) for non-member group. The average price received per litre milk for overall category was significantly higher for non-member group (Rs.20.20/litre) than that of member group (Rs.18.58/litre). The average price received per litre milk was Rs.18.43, Rs.18.93 and Rs.18.53 for small, medium and large category farmers in member category, respectively. The same in non-member category was Rs.20.09 and Rs.20.62, respectively for small and medium farmers.

TABLE 7. MILK MARKETING PATTERNS IN HILLS

(*per household per day*)

(1)	Milk production (2)	Milk yield (3)	Milk retained (4)	Milk requirement* (5)	Marketable surplus (6)	Marketed surplus (7)	Marketed surplus (per cent) (8)	Price received (Rs./lit.) (9)
Members								
Small	7.55	5.87[a]	3.00[a]	1.02	6.53	4.55	60.26	18.43[a]
Medium	11.88	5.15	5.25	1.15	10.73	6.63	55.81	18.93[a]
Large	18.47	5.42	3.15	1.15	17.32	15.32	82.95	18.53[a]
Overall	10.50	5.61[b]	3.61	1.10	9.43	6.89	65.62	18.58[a]
Non-members								
Small	8.57	6.81[a]	2.50	1.12	6.45	6.07	70.83	20.09[a]
Medium	10.81	4.70	3.55[0]	1.30	9.51	7.26	67.16	20.62[a]
Large	-	-	-	1.33	-	-	-	-
Overall	9.05	6.36[b]	2.73	1.16	7.89	6.33	69.94	20.20[a]

*Milk requirement per household calculated as per ICMR recommendations (300 ml per capita per day).

Differences between figures – pertaining to a particular parameter – having same superscripts across herd-size categories over groups are significant.

Factors Influencing Co-operative Membership

The results of Logit analysis carried out to ascertain the factors that influence co-operative membership for plains and hills are presented in Table 8. A perusal of the table reveals that distance to market, landholding size and non-farm income were the variables that significantly (P<0.10) influenced farmers' membership in dairy co-operatives in the plains. The signs of the regression coefficients for all these variables were positive. The positive sign associated with the variable distance to market imply that the probability of being a member of co-operative society increases with increase in distance from market. This is understandable as larger is the distance to market fewer is the number of alternative marketing agencies available to farmers. Larger distance to market also implies higher transaction costs for farmers if they want to sell in the market, which encourages their choice of co-operative society as point for first sell. Size of landholding had positive influence on likelihood of farmers' participation in dairy co-operatives, suggesting that the marginal and small landholders are relatively excluded from co-operative membership, indicating that households which are less dependent upon dairying and agriculture are more likely to be members of co-operative societies.

In the hills, herd size, distance to market and education of household head were the significant variables affecting co-operative membership. The signs of regression coefficients for all the variables were positive. Probability of co-operative membership increased with increase in herd size. This is in contrast with the findings of Bravo-Ureta and Lee (n.d.) who in a study in New England observed non-significant influence of scale of production with dairy co-operative membership.

TABLE 8. FACTORS INFLUENCING CO-OPERATIVE MEMBERSHIP (LOGIT ESTIMATES)

Particulars	Plains		Hills	
	β	χ^2	β	χ^2
(1)	(2)	(3)	(4)	(5)
Intercept	0.385	0.037	-2.059	0.408
	(1.991)		(3.221)	
Herd size	-0.155	0.643	2.392	2.634*
	(0.193)		(1.474)	
Distance to market (km)	0.204	2.191*	0.237	1.684*
	(0.138)		(0.183)	
Age of HH head (yrs.)	-0.010	0.183	0.017	0.173
	(0.024)		(0.040)	
Education-HH head	-0.071	0.191	0.609	1.846*
	((0.162)		(0.449)	
Land owned (acres)	0.187	1.651*	1.245	0.417
	(0.146)		(1.927)	
Access to information (Y=1, N=0)	-0.637	0.398	-1.452	1.076
	(0.713)		(1.399)	
Non-farm income (Y=1, N=0)	0.889	1.836*	-4.292	1.388
	(0.656)		(3.049)	
-2 Log likelihood	71.679		36.632	
R^2 (McFadden)	0.164		0.418	
R^2 (Cox and Snell)	0.175		0.375	
Per cent Correct Predictions	76.71		85.71	

*Significant at 10 per cent level of significance.
Figures in parentheses indicate standard errors.

Greater distance to market encouraged co-operative membership and likelihood of participation in co-operatives increased with increase in education level of household heads. Association between age and co-operative membership was found to be statistically non-significant in both the plains and the hills. This is consonance with the earlier findings of Francesconi and Ruben (2007) who also reported non-significant influence of age on co-operative membership in milk shed of *Debre Zeit* near Addis Ababa, Ethiopia.

Factors Influencing Farmers' Intensity of Market Participation

Multivariate regression equations were fitted – one each for the plains and the hills – wherein the proportion of milk output sold was the dependent variable and a dummy variable representing co-operative membership status was an independent variable along with other variables representing farm and farmer characteristics and transaction cost variables to ascertain the influence of participation in co-operatives on the intensity of participation. In case of plains, significant correlation was observed between herd size and milk production. The parameters of the model improved significantly, when the variable milk production was dropped. In case of hills, however, no correlation between the above two variables was found. Hence, both the variables, i.e., herd size and milk production were included in the final model for the hills. While in case of plains, only her size variable was considered in the final model.

The results of the regression analyses are presented in Table 9. The independent variables included in the models explained 29 per cent and 27 per cent variations in the dependent variable in case of the plains and the hills, respectively. The significant values of 'F' statistics for both the regression equations indicate goodness of fit of data. In case of the plains, the variables which significantly influenced farmers' intensity of market participation were price received for milk, herd size and size of landholding. While the effects of price received and landholding size were negative, that of herd size was positive. The negative effect of price on proportion of output sold implies that farmers who received lesser price for milk were inclined to bring a higher proportion of their milk output to marketed surplus so as to compensate for lower price per unit of milk with higher volume. Households having larger landholdings are less dependent on dairying for their livelihood and hence retained a greater proportion of their output for home consumption, which was reflected by the negative effect of landholding size on proportion of output sold. The positive influence of herd size implies that with the increase in farmers' scale of operation, their intensity of market participation also increases.

TABLE 9. FACTORS INFLUENCING LEVEL OF COMMERCIALISATION (PROPORTION OF OUTPUT SOLD)

	Plains		Hills	
	β	SE	β	SE
(1)	(2)	(3)	(4)	(5)
Intercept	0.944***	0.188	0.649***	0.229
Price received	-0.011*	0.005	0.011*	0.006
Herd size	0.030**	0.015	-0.027	0.041
Family size	-0.026	0.021	-0.031	0.025
Education-HH head	-0.010	0.012	-0.013	0.017
Age-HH head	-0.002	0.002	-0.029	0.002
AH is main occupation (Y=1, N=0)	0.067	0.057	-0.062	0.214
Non-farm income (Y=1, N=0)	0.077	0.051	0.025	0.054
Landholding	-0.013**	0.005	-0.030	0.027
Milk production			0.015***	0.005
COOP. MEMB. (Y=1; N=0)	-0.046	0.056	-0.001	0.059
R^2	0.289		0.268	
F-value	2.849*		1.949*	

***, ** and * Significant at 5 and 10 level respectively.
Figures in parentheses indicate standard errors.

Factors Influencing Farmers' Technical Efficiency in Milk Production

Table 10 elicits the results of the multivariate linear regression analysis carried out to identify the significant factors influencing technical efficiency of dairy farms, in the plains and hills. Pooled regression equations across all herd-size categories over groups were fitted in case of both the plains and hills. A dummy variable (co-operative membership) was included in the models to capture the effect of

TABLE 10. FACTORS INFLUENCING TECHNICAL EFFICIENCY OF FARMS IN PLAINS

Variables	Plains		Hills	
	β	SE	β	SE
(1)	(2)	(3)	(4)	(5)
Constant	0.659***	0.095	1.062***	0.133
Education-HH head	2.007E-03	0.006	8.734E-04	0.010
Age-HH head	8.087E-04	0.001	-2.71E-04	0.001
Land holding size	3.705E-03	0.003	8.213E-03	0.016
Herd size	9.745E-04	0.007	-5.68E-03	0.019
Non-farm income (Y=1, N=0)	-1.42E-02	0.023	2.926E-02	0.030
Prop. Of output sold	2.351E-02	0.057	1.650E-02	0.083
Price received	8.227E-03**	0.003	-3.48E-03	0.005
Access to Info. (Y=1; N=0)	4.563E-02**	0.022	2.84E-02	0.035
COOP. MEMB. (Y=1; N=0)	-2.36E-02	0.026	-0.141***	0.035
R^2	0.235		0.351	
F-value	2.156**		2.769**	

*** and ** Significant at 1 and 5 per cent level.

participation in dairy co-operatives on technical efficiency of farms. The variables price received and access to information significantly and positively influenced technical efficiency of farms in the plains. No other variables were found to impact level of technical efficiency, significantly. Higher price received by the farmers for milk provides extra incentives to farmers to take better care of their animals and manage the farms efficiently. Easy access to information provides the farmers the technical know how required to manage their farms efficiently. Co-operative membership was found to have no significant influence on technical efficiency, indicating that mere participation in dairy co-operatives does not guarantee higher level of technical efficiency. Gelan and Muriithi (2010) had also observed in a study in East Africa that did not have a statistically significant effect on efficiency in milk production. In the hills, in the extension area, only the variable co-operative membership had significant influence on technical efficiency. The effect was, however, negative, implying that non-participants are more efficient in managing their farms. This is consistent with the earlier findings, which showed that the mean technical efficiency of non-member farms was substantially higher than that of member farms.

Impact of Co-operative Membership on Selected Economic Parameters

‘t’ test was used to compare the selected economic parameters among member and non-member groups. Co-operative membership had no influence on herd size in both the plains and the hills as the differences between average herd sizes per household of member and non-member group was statistically non-significant (Table 11). While the productivity across the two groups in the plains were not significantly different, that of non-member households in the hills was significantly higher than that of member households. This implies that the effect of participation in DCS in the hills has not been favourable in regard to increasing the productivity of animals.

TABLE 11. IMPACT OF PARTICIPATION IN DAIRY COOPERATIVES ON SELECTED ECONOMIC PARAMETERS

	Plains		Hills	
Parameters	Members	Non-members	Members	Non-members
(1)	(2)	(3)	(4)	(5)
No. of milk animals (SAU)/HH	2.59	2.80	2.57	2.01
Productivity	6.66	5.93	5.61[a]	6.36[a]
Home Consumption	5.56	4.72	3.61	2.73
Marketed surplus	11.44	10.70	6.89	6.33
Access to information	0.79[a]	0.50[a]	0.51	0.34
Price received for milk	16.27[a]	18.11[a]	18.58[b]	20.20[b]
Employment generation (if hired labour employed = 1, No hired labour employed = 0)	0.23[a]	0.11[a]		

Differences between figures-pertaining to a particular parameter – having same superscripts are statistically significant.

Non-significant effect of co-operative membership was observed in regard to volume of milk retained for home consumption and volume of milk sold as the difference between these variables were not statistically significant across member and non-member groups in both the hills and plains. Non-member farmers received significantly higher prices in both the plains and the hills than member farmers. A favourable effect of co-operatives was observed in case of providing easy access to information and employment generation in the plains. No such impact was, however, observed in the hills.

IV

CONCLUSION

Likelihood of a farmer being a member of co-operative increased with increase in distance to market in both the plains and the hills. Greater distance to market implies higher transaction costs for farmers, which encourages their choice of DCS located in their villages as point for first sale. In the plains, evidence emerged that farmers with larger landholding and with non-farm income source were more likely to participate in DCS, implying that the resource poor farmers – who are more dependent on dairying for their livelihood – preferred alternative marketing channels for sale of their produce.

Price and scale of production were identified as the two most important policy variables favourably influencing intensity of market participation in both the plains and the hills, and hence can be used as policy instruments in enhancing producers' level of commercialisation. Co-operative membership was observed to have no significant effect on farmers' level of commercialisation in both the regions. Price and information access were the policy variables that significantly influenced technical efficiency in milk production in the plains. While co-operative membership did not have any significant influence on technical efficiency in the plains, in the hills, the effect of co-operative membership was significant but negative, implying that non-participants are more efficient in managing their farms. Non-member farmers received significantly higher prices in both the plains and the hills than member farmers, implying that farmers' choice of DCS as marketing agency was driven more by the fact that the co-operatives offered an assured marketing outlet in their villages, rather than any incentives in regard to remunerative price offered by them.

V

POLICY IMPLICATIONS

It is necessary to enhance collaboration between extension service providers and farmers as revealed by the favourable impact of information access on technical efficiency. Access to extension services will also ensure uptake of improved dairy technologies which in turn will enhance the scale of milk production and contribute to increased marketable surplus. To make dairying more remunerative, price is a very important factor to consider as it often acts as an incentive for farmers to scale up their production. Dairy co-operatives follow a two-axis policy in regard to fixing price for milk. It is imperative that factors other than fat and SNF be considered for fixing of milk price by the co-operatives. For this, price based upon the total cost of milk production (including imputed value of family labour charges) rather than only fat and SNF can go a long way in offering remunerative prices to member farmers. However, cognisance needs to be taken of quality of milk (as denoted by fat and SNF content) that is produced by the farmers. Thus, a model needs to be developed so as to standardise milk production costs as per the specified quality levels of milk. This would enable linking of milk production cost with quality of milk and hence guarantee remunerative price to the producers as well as provide enough incentives to them in producing milk of adequate quality.

Received May 2012. Revision accepted December 2012.

NOTE

1. The following standards were used to standardise herd size of the farm households:

Milch buffalo	1.30
Milch crossbred cow	1.40
Milch indigenous cow	1.00

REFERENCES

Aigner, D.J.; Lovell, C.A.K. and Schmidt, P. (1977), "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, Vol.6, pp.21-37.

Arora, V.P.S.; T.S. Bhogal and P.G. Biswas (1998), "Milk Marketing in North-West Uttar Pradesh and the Role of Dairy Co-operatives – A Temporal Analysis", *Indian Cooperative Review*, Vol.36, No.1, pp.70-77.

Bardhan, D.; M.L. Sharma and Rekha Saxena (2010), “Livestock in Uttarakhand: Growth Patterns and Determinants of Composition and Intensity”, *Indian Journal of Animal Sciences*, Vol.80, No.6, pp.584-589.

Birthal, P.S. and V.K. Taneja (2006), “Livestock Sector in India: Opportunities and Challenges”, in P.S. Birthal; V.K. Taneja and W. Thorpe (Eds.), *Smallholder Livestock Production in India: Opportunities and Challenges,* National Centre for Agricultural Economics and Policy Research, New Delhi and International Livestock Research Institute, Nairobi, Kenya.

Bravo-Ureta, E. Borris and Lee, Tsoung-Chao, n.d., *Socioeconomic and Technical Characteristics of New England Dairy Cooperative Members and Non-members*, Scientific Contribution No.1222, Storrs Agricultural Experiment Station, University of Connecticut.

Costales, Achilles; Christopher, Delgado, Catelo, Delgado, Maria Angeles; Lapar, Ma Lucia; Tiongco, Marites; Ehui, Simeon and Bautista, Anne Zillah (2007), *Scale and Access Issues Affecting Smallholder hog Producers in An Expanding Peri-Urban Market: Southern Luzon, Phillippines,* Research Report 151, International Food Policy Research Institute, Washington, D.C., U.S.A.

Deinenger, K.W. (1993), *Co-operatives and the Break-up of Large Mechanised Farms: Theoretical Perspectives and Empirical Evidence,* World Bank, Discussion Paper No.218, The World Bank, Washington, D.C., U.S.A.

Dixit, P.K. (1999), “Bovine Economy in Mandya District of Karnataka Stare – A Sustainability Oriented Analysis”, National Dairy Research Institute (Deemed University), Karnal, Ph.D. Thesis (Unpublished).

Francesconi, Gian Nicola and Ruben, Ruerd (2007), “Impacts of Collection on Smallholders’ Commercialisation: Evidence from Dairy in Ethiopia”, in Proceedings of 1 Mediterranean Conference of Agro-Food Social Scientists and 103rd EAAE Seminar, Adding Value to the Agro-Food Supply Chain in the Future Euro-Mediterranean Space, Barcelona, Spain, 2007.

Gelan, Ayele and Muriithi (2010), “Measuring and Explaining Technical Efficiency of Dairy Farms: A Case Study of Small Holder Farms in East Africa”, in Proceedings of 3rd Conference of African Association of Agricultural Economists on Africa and the Global food and financial Crises, Cape Town, South Africa, 19th-23rd September, 2010.

Government of India (2008), *Basic Animal Husbandry Statistics*, Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture, New Delhi.

Hemme, T. (2000), “Ein Konzept Zur International Vergleichenden Analyse von Politik and Technikfolgen in der Landwirtschaft”, Ph.d. Thesis, Gottingen University, Gottingen, Germany.

Kumar, Anjani, Pratap S. Birthal and Badruddin (2004), “Technical Efficiency in Milk Shrimp Farming in India: Estimation and Implications”, *Indian Journal of Agricultural Economics*, Vol.59, No.3, July-September, pp.413-420.

Kumar, P. and Singh, R.P. (1980), “Dynamic Feed-Milk Relationship and Technological Change in Milk Production”, *Indian Journal of Agricultural Economics*, Vol.35, No.4, October-December, p.126.

Kumbhare, S.L.; K.N.S. Sharma and R.K. Patel (1983), “Standardization of Bovine Units”, *Indian Journal of Animal Science*, Vol.53, p.547.

Rao, Sambasiva, B. and Mohan B. Jagan Rao (1991), “Income and Employment Generation of Crop and Dairy Enterprises”, *Indian Journal of Dairy Science*, Vol.44, No.5, pp.319-322.

Saha, A.K. and D.K. Jain (2004), “Technical Efficiency of Dairy Farms in Developing Countries: A Case Study of Haryana State”, *India, Indian Journal of Agricultural Economics*, Vol.59, No.3, July-September, pp.588-599.